

# Building Effective Search Systems Help-MateAI Project

## 1. Background

This project demonstrate “Building Effective Search Systems HelpMateAI” with a long insurance policy document using RAG techniques.

## 2. Problem Statement

The goal of the project is to build a robust generative search system capable of effectively and accurately answering questions from a policy document.

We will be using a single long life insurance policy document for this project.

## 3. Document

1. The policy document can be found [here](#)

## 4. Approach

The project should implement all the three layers effectively. It will be key to try out various strategies and experiments in various layers in order to build an effective search system. Let’s explore what we need to do in each of the layers.

1. **The Embedding Layer:** The PDF document needs to be effectively processed, cleaned, and chunked for the embeddings. Here, the choice of the chunking strategy will have a large impact on the final quality of the retrieved results. So, we need to make sure that we try out various stratgies and compare their performances.

Another important aspect in the embedding layer is the choice of the embedding model. we can choose to embed the chunks using the OpenAI

embedding model or any model from the SentenceTransformers library on HuggingFace.

2. **The Search Layer:** Here, we need to design at least 3 queries against which you will test your system. You need to understand and skim through the document, and accordingly come up with some queries, the answers to which can be found in the policy document.

Next, we need to embed the queries and search your ChromaDB vector database against each of these queries. Implementing a cache mechanism is also mandatory.

Finally, we need to implement the re-ranking block, and for this we can choose from a range of cross-encoding models on HuggingFace.

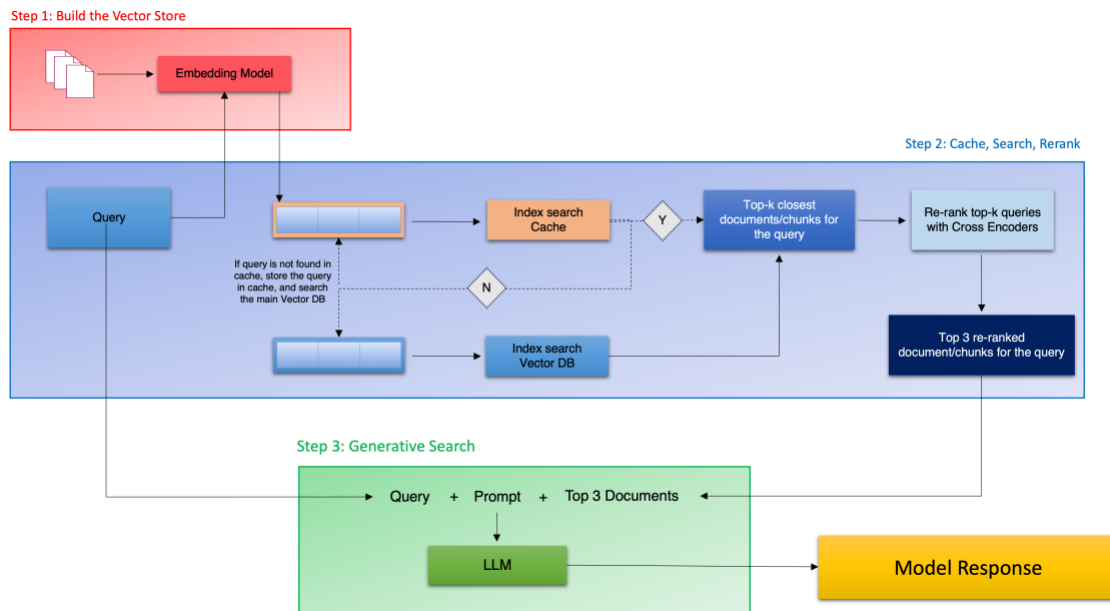
3. **The Generation Layer:** In the generation layer, the final prompt that we design is the major component. We need to make sure that the prompt is exhaustive in its instructions, and the relevant information is correctly passed to the prompt. We may also choose to provide some few-shot examples in an attempt to improve the LLM output.

## 5. System Layers

- **Reading & Processing PDF File:** We will be using pdfplumber to read and process the PDF files. pdfplumber allows for better parsing of the PDF file as it can read various elements of the PDF apart from the plain text, such as, tables, images, etc. It also offers wide functionalities and visual debugging features to help with advanced preprocessing as well.
- **Document Chunking:** The document contains several pages and contains huge text, before generating the embeddings, we need to generate the chunks. Let's start with a basic chunking technique, and chunking the text with fixed size.
- **Generating Embeddings:** Generates embedding with SentenceTransformer with all-MiniLM-L6-v2 model.
- **Store Embeddings In ChromaDB:** In this section we will store embedding in ChromaDB.

- **Semantic Search with Cache:** In this section we will introduce cache collection layer for embeddings.
- **Re-Ranking with a Cross Encoder:** Re-ranking the results obtained from the semantic search will sometime significantly improve the relevance of the retrieved results. This is often done by passing the query paired with each of the retrieved responses into a cross-encoder to score the relevance of the response w.r.t. the query.
- **Retrieval Augmented Generation:** Now we have the final top search results, we can pass it to an GPT 3.5 along with the user query and a well-engineered prompt, to generate a direct answer to the query along with citations.

## 6. System Architecture



## 7. Prerequisites

- Python 3.7+
- Please ensure that you add your OpenAI API key to the empty text file named “OpenAI\_API\_Key” in order to access the OpenAI API.

## 8. Query Screenshots

```
query = 'what is the life insurance coverage for disability'
df = search(query)
df = apply_cross_encoder(query, df)
df = get_topn(3, df)
response = generate_response(query, df)
print("\n".join(response))
```

```
/usr/local/lib/python3.11/dist-packages/torch/nn/modules/module.py:1750: FutureWarning: `encoder_attention_mask` is deprecated and will be removed in version 4.55.0 for `BertSdpaSelfAttention`
return forward_call(*args, **kwargs)
The life insurance coverage for disability is provided in the Member Life Insurance or Coverage During Disability section of the insurance policy document on Page 42. The document outlines the following details:

**Citation:**
- Policy Name: Member Life Insurance or Coverage During Disability
- Page Number: Page 42
```

```
query = 'what is the Proof of ADL Disability or Total Disability'
df = search(query)
df = apply_cross_encoder(query, df)
df = get_topn(3, df)
response = generate_response(query, df)
print("\n".join(response))
```

```
/usr/local/lib/python3.11/dist-packages/torch/nn/modules/module.py:1750: FutureWarning: `encoder_attention_mask` is deprecated and will be removed in version 4.55.0 for `BertSdpaSelfAttention`
return forward_call(*args, **kwargs)
The Proof of ADL Disability or Total Disability in the insurance policy document refers to the documentation required to support a claim for benefits based on either Activities of Daily Living or Total Disability.

In the provided documents, the relevant information can be found in the following section:

**Member Life Insurance or Coverage During Disability (Page 42, Chunk 4):**
- The specific requirements for providing proof of ADL disability or total disability will be outlined in this section of the policy document.

Based on the content of the document, it is important to review the detailed requirements and procedures mentioned in the "Member Life Insurance or Coverage During Disability" section on Page 42.

For further details and specific instructions, please refer to the detailed content in the policy document section mentioned above.

**Citations:**
- **Policy Name:** Member Life Insurance or Coverage During Disability
- **Page Number:** Page 42
```

```
query = 'what is condition of death while not wearing Seat Belt'
df = search(query)
df = apply_cross_encoder(query, df)
df = get_topn(3, df)
response = generate_response(query, df)
print("\n".join(response))
```

```
/usr/local/lib/python3.11/dist-packages/torch/nn/modules/module.py:1750: FutureWarning: `encoder_attention_mask` is deprecated and will be removed in version 4.55.0 for `BertSdpaSelfAttention`
return forward_call(*args, **kwargs)
The insurance policies do not cover conditions of death specifically related to not wearing a seat belt. It is important to follow all safety guidelines and regulations when operating a vehicle.

Citations:
1. Policy Name: Member Life Insurance or Coverage During Disability
   Page No.: Page 42
2. Policy Name: Dependent's Life Insurance
   Page No.: Page 44
```